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Determinants of energy demand in African frontier market economies: An empirical investigation

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Abstract

Since the turn of the twenty-first century, the economic performance of Africa has been remarkable. We identify the key factors driving energy consumption from seven frontier market economies in Africa. More specifically, the role of economic, financial, and trade integrations are explored as the source of overall energy demand. First, we establish cross-sectional dependence and heterogeneity across countries. Second, the long-run elasticities of energy consumption reflect the key role of stock market indicators, along with industrialisation and trade openness while foreign direct investment (FDI) inflows have a reducing effect. In this respect, the long-run energy elasticities on individual countries show a considerable variation. Finally, the heterogeneous panel non-causality test confirms that the energy consumption has a feedback relationship with stock market indicators and industrialization. Our findings reflect that the environmental planning should comprise development in financial and trade sectors in boosting economic growth and increasing energy demand for these countries.

JEL classification: C23, G18, Q40, Q41, Q48

Keywords: Stock market development, energy consumption, African frontier markets, cross-sectional dependence

1. Introduction

According to a recent report by the International Energy Agency (IEA, 2014), around 70% of the population in sub-Saharan Africa live without electricity. In most African countries, access to electricity is very low due to high cost, which creates low competitiveness in the industrial sector and eventually leads to energy poverty and hindered economic growth. A report by the African development bank group (2013) states 'the main obstacle to the increase in electricity generation capacity is the high cost of producing electricity, forcing governments to subsidize consumption'.[1] In order to realize sustainable growth in the future, Africa must deal with increasing energy demand, implement adequate market reforms, and commit to the improvement of power and logistics' infrastructure.

What are the major drivers of energy consumption in Africa? In recent times, the global financial environment has expanded the horizons in African frontier market economies.[2] These countries are trying to maximise their use of resources and avoid the so called 'resource curse', or paradox of plenty. Due to the abundant human capital resources, GDP growth and stable inflation scenarios, massive monetary stimulus from the US, other major countries are seeking this region as their new market destination. Furthermore, access to capital markets is a key ingredient in recent times for sustainable private sector-led growth. We choose seven frontier economies in Africa viz. Botswana, Ghana, Kenya, Morocco, Nigeria, Tunisia, and Zimbabwe. These frontier markets have a great potential for the expansion of economic activities. Hence, these economies attract the global investors for exploring the investment opportunities. More specifically, the frontier markets are

[1] https://www.afdb.org/en/blogs/afdb-championing-inclusive-growth-across-africa/post/the-high-cost-of-electricity-generation-in-africa-11496/

[2] Details on African frontier markets are discussed in United Nations: Economic Commission for Africa (2014).

particularly interesting for the global investors as these markets offer-diversifying opportunities and provide higher risk-adjusted returns.

The stock markets of these frontier economies are increasingly gaining momentum as major financial channels for savings and investment purposes. The World Bank, along with other international bodies, has been proactive in building investment opportunities with private-public partnership.[3] Rapid urbanisation is driving increased efficiency; small-scale industrialisation and infrastructure in major cities have also become attractive to foreign investors. The growth trajectory is expected to continue in the coming decade for these economies.

Natural resource-rich countries have also become the subject of Chinese investment and trade. Indian investment in Africa has increased in the telecommunications, agriculture, infrastructure and mining sectors, and Brazil is now competing with China and India in investing in this continent. In 2014, Africa attracted higher FDI funding compared to North America, Latin America and the Caribbean, and Western Europe (except Asia Pacific region, which ranked first).[4] The independence of central banks across countries, governance and legislation has improved in the recent past, and debt to GDP ratio is 34%. By the end of 2012, capital from infrastructure projects exceeded US$700b, of which 24.9% (US$176b) was in the power sector.

Expansion of primary commodity export markets and domestic economic activity has been the sources of African growth. Unlike East Asian countries, Africa needs structural transformation. Aryeetey and Moyo (2012) and other researchers have identified sectoral reform as one of the driving factors for sustainable development in Africa. They suggest, manufacturing, agro-industry and tradeable services led industries be the viable path in accelerating structural changes. The

[3] See http://www.icafrica.org/fileadmin/documents/guides/Attracting-investors-to-African-PPP.pdf for further detail.
[4] Ernst and Young: EY, (2015)

energy sector plays a significant role in promoting technology and transformation (Ajakaiye and Page, 2012).

Current revenue is mostly from natural resources and primary sector which can be vulnerable to external shocks. Africa needs to invest in key sectors like energy, manufacturing and agriculture. These African frontier market economies are in the epicentre of the global energy challenges in overcoming energy poverty. In 2009, the World Bank established the Africa Renewable Energy and Access program (AFREA) to meet energy demand and widen access to energy services in Sub-Saharan African countries in a sustainable environment. Capital flows to Sub-Saharan Africa increased in recent time, reaching an estimated 5.3 percent of regional GDP in 2013, significantly higher than the developing countries (World Bank, 2014).

This paper constitutes a first attempt in identifying interactive roles between stock market development, trade openness and economic activity on energy demand for these frontier countries. The continued stock market development in these frontier market economies increases financial capital and investment flows across borders and allows greater access to the new energy efficient products and technology. All of these may affect the demand for energy by increasing production activities. Stock market development is also attractive for business growth as it allows access to equity financing in addition to debt financing. Increased stock market activities can help to diversify the risk for both consumers and businesses, increasing confidence and having significant positive impact on wealth of the economy (Sadorsky, 2010). Further, Sadorsky (2010) argues that increase in stock market activities raises energy consumption in emerging economies. Therefore, our first objective is to analyse the dynamics of energy consumption with the expansion of stock market and how the increasing energy demand needs to be tackled in future for these countries?

Along with stock market, we consider the role of continued industrialisation and internationalisation in economic activities and increasing energy demand.[5] The introduction of new product and technology in the production process can hasten industrialisation, which ultimately uses more energy than the traditional sectors. Trade openness increases economic activities, thus stimulating domestic production and economic growth, and also influences energy demand via the composition, scale and technique effects. Trade openness increases the size of market through the scale effect, increasing domestic production and energy demand.

Foreign presence in domestic market has a positive spillover on productivity and growth. FDI may decrease energy consumption through technology transfer to the host country, which promotes less energy consumption by increasing energy efficiency. FDI can also improve the efficiency of energy utilisation of the host country by restructuring the production process. Therefore, our second objective is to test the effects of industrialisation, trade and foreign ownership on energy consumption. The economic condition of a country and the extent of the relationship between economic growth and trade openness determine the impact of trade openness on energy consumption. Our final objective is to utilise the robust panel estimation techniques, which can capture the cross-sectional dependence and heterogeneity across countries reflecting regional differences.

We establish a significant dynamic feedback effect across the most of our considered variables. The long-run elasticities are analysed for individual countries. We suggest, the African frontier market economies should engage more in foreign investment, trade and stock market activities in integrating energy for sustainable growth within the region.

[5] Increasing industrialisation (gradual shift from agrarian economy) and internationalisation (access to global markets) are in priority for this African frontier market economies.

The paper is set as follows. Section 2 covers brief overview of the literature focussing on economic growth, stock market indicators, and energy consumption. Section 3 introduces nature of data and measurement of variables, model specification, and empirical methodology. Section 4 presents empirical findings and discussion. Final section summarises our findings with policy suggestions.

2. A brief overview of literature

The overview covers two strands of literature. In the first sub-section, we cover economic growth-energy consumption nexus, followed by the literature relating to stock market activity, trade, industrialisation, and energy consumption. Literature directly related to African countries is used preferentially, where possible.

2.1 Economic growth and energy consumption

The existing literature linking economic growth and energy consumption is voluminous. Four general hypotheses have been portrayed. *The growth hypothesis* considers energy as one of the main inputs, together with other conventional inputs into the growth process (Apergis and Payne 2009; Bhattacharya, et al. 2016, 2017; Paramati et al. 2017e; Ozturk 2010; Payne 2010a, 2010b), and the substitution of energy with other inputs occurs with the stages of development of a particular country. *The conservation hypothesis* implies that economic growth causes increase in energy consumption, and that energy saving under this scenario will not hamper economic growth. *The feedback hypothesis* reflects a bi-directional causality between these two variables. Energy consumption and economic growth are complementary in this scenario. Finally, *the neutrality hypothesis* relies on the absence of causality between these two variables. Smyth and Narayan (2015), Yildirim et al. (2014) reviewed the empirical literature and concluded that the findings

varied due to the stages of development, time period considered and econometric techniques used in the empirical literature.

In an analysis of eleven countries from Sub-Saharan Africa, Akinlo (2008) showed that energy consumption and economic growth are cointegrated for Cameroon, Cote d'Ivoire, Gambia, Ghana, Senegal, Sudan and Zimbabwe. In addition, a positive long-run effect on economic growth was established for Ghana, Kenya, Senegal and Sudan; a bi-directional relationship between energy consumption and economic growth was found for Gambia, Ghana and Senegal. However, Granger causality tests indicated that a relationship exists between economic growth and energy consumption in the case of Sudan and Zimbabwe. The neutrality hypothesis was established for Cameroon and Cote d'Ivoire. The findings suggest that different energy policies should be implemented in different African countries.

Bhattacharya et al. (2016) explored the impact of renewable energy consumption on the economic output in a panel of 38 major renewable energy-consuming economies around the world. Their study has utilized annual data from 1991 to 2012 and employed robust panel econometric techniques. Their long-run output elasticities, based on the dynamic ordinary least squares (DOLS) and fully modified OLS (FMOLS), indicated that the renewable and non-renewable energy consumptions have significant positive impact on the economic growth. Similarly, Bhattacharya et al. (2017) also analysed the effect of renewable energy consumption on economic growth across the 85 developed and developing economies around the world. The findings from their analyses confirmed that both the renewable energy and non-renewable energy consumptions played an important role in promoting sustainable economic development across the regions. Another recent study by Paramati et al. (2017e) examined the role of renewable energy consumption on the economic output across a panel of Next-11 emerging economies. Authors utilized annual data from

1990 to 2012 and employed FMOLS model to estimate the long-run elasticities. Their results indicated that the non-renewable and renewable energy consumptions have considerable positive impact on the economic output in emerging economies.

Dogan (2014) investigated the causal relationship between energy consumption and economic growth in case of four low-income countries of Sub-Saharan Africa. The Granger causality test indicated unidirectional causality from energy use to economic growth in Kenya and no causality relationship for Benin, Congo or Zimbabwe. Osigwe and Arawomo (2015) examined the causality relationships between energy consumption, oil price and economic growth in Nigeria. Their findings reflect that bidirectional causality exists between energy consumption and economic growth.

For South Africa, Menyah and Wolde-Rufael (2010) established a dampening effect of economic growth on the reduction of pollutant emissions. In the long-run, their findings suggest that South Africa needs to find alternative sources of energy other than coal in reducing future emissions. In a panel study of thirty Sub-Saharan countries, Al-Mulali and Sab (2012) investigated the impact of energy consumption and CO_2 emissions on GDP growth. Their findings establish the importance of energy consumption both for economic and financial development. Investment in energy sector has, therefore, been identified as a major policy tool.

2.2 Stock market, industrialisation, internationalisation, and energy consumption

The literature on the influence of stock market development on overall energy consumption is still embryonic. For the purpose of this review, we include studies in which the stock market indicator is considered as a proxy for financial development. Zhang et al. (2011) investigated the influence of Chinese stock market development on energy demand considering grey relational analysis and

the Granger causality test. The grey relational grade was relatively high for stock market scale with 0.84 while for efficiency with 0.73. This shows that the rapid development of the Chinese stock market has become a prominent driver for energy consumption, and the scale effect from the stock market is greater than efficiency effect on energy consumption.[6]

Sadorsky (2010) reported a positive and statistically significant relationship between stock market turnover and energy consumption in 22 emerging countries, along with other indicators from financial markets. Author emphasised that the energy demand projections will be understated if the role of financial development is not considered into the policy framework. His findings indicate that energy conservation policies may fall short of the intended targets when the energy demand from financial sector is not taken into account explicitly.[7]

To derive further empirical evidence, Sadorsky (2011) analysed the effect of financial development on energy consumption in case of Central and Eastern European frontier countries. A positive and significant relationship was established between financial development and energy consumption when stock market turnover is used as a proxy for financial development. For these economies, stock market turnover (scale) has a positive and significant impact on energy consumption both in the short- and long-run. To the authors' knowledge, there is no study using stock market turnover as an indicator to explain the financial development-energy demand nexus in Africa.

[6] The previous literature also establishes significant effect of stock market performance on economic growth. For instance, the empirical findings of Paramati and Gupta (2011) reported that the economic growth causes stock market development in case of India.

[7] A very recent study by Paramati, Alam and Apergis (2017a) establish that the stock market indicators have considerable negative and positive impact on the CO_2 emissions of developed and emerging market economies, respectively. Given these findings, authors argue that the impact of stock markets on CO_2 emissions is not uniform across the markets. Therefore, it is important to classify the sample countries into developed and emerging markets for a better understanding of their association in the long-run.

Shenggang et al. (2014) estimated the CO_2 emissions related to China's international trade using an input–output analysis. Based on industrial panel data, their findings suggest that trade surplus and large FDI are the important reasons for the rapid rise of CO_2 emissions in China. Nasreen and Anwar (2014), and Shahbaz et al. (2014) also documented similar conclusions. Shahbaz and Lean (2012) assessed the relationship between energy consumption, financial development, economic growth, industrialisation and urbanisation in Tunisia. Long-run bidirectional causality was found between industrialisation and energy consumption. Along with other control variables, the role of industrialisation for economic growth was emphasised. Al-Mulali and Sab (2012) examined the role of energy in the form of increasing energy efficiency, implementing energy saving projects, energy conservation, and energy infrastructure in fostering financial development in Sub-Saharan African countries.

FDI influx induces energy consumption through the expansion of industrialisation, and the development of transportation and manufacturing sectors. This has been shown by Foon Tang (2009) for Malaysia. Mielnik and Goldemberg (2000), and Sadorsky (2010) also established a positive relationship between FDI and energy demand for developing countries. FDI facilitates cheaper and easier access to financial capital to the business. These can be used to expand their existing operations or construct new plants and factories, which increase energy demand. In Table 1, besides the above studies, we summarise some recent studies relating to energy consumption with stock market indicators.

[Insert Table 1 here]

It is apparent from this brief review that the relationship between stock market development and energy consumption is not uniform across countries. It depends on the stage of

economic development of the countries considered, estimation methods, nature of data and time periods. There is no study particularly focusing on the effects of stock market indicators on energy consumption in case of the African frontier market economies.[8] As discussed in the preceding section, these frontier market economies will play a significant role in trade and investment in the future global energy arena.

3. Data and empirical methodology

3.1 Nature of data and measurement issues

Data on energy consumption, real GDP per capita, indicators of stock market, industrialisation, trade and foreign direct investment was collected from Q4 1991 to Q4 2012 for the countries of interest.[9] Increasing the frequency of the series in the sample will increase the power and robustness of our findings. In this study, a balanced panel dataset of the following seven frontier market economies of Africa were used: Botswana, Ghana, Kenya, Morocco, Nigeria, Tunisia, and Zimbabwe. The selection of the sample period was based on the availability of data and countries were selected based on the list of African frontier markets as per the Morgan Stanley Capital International (MSCI). We display the locations of these frontier markets in the African region in Figure 1. These frontier market economies have considerable potential for the expansion of economies activities which requires significant energy supply. Therefore, the policy makers need to frame the appropriate policies to meet the increasing demand for energy in these countries.

[Insert Figure 1 here]

[8] To our knowledge, only study by Le (2016) is on Sub-Saharan Africa. A bi-directional causality is established between financial development and energy consumption.

[9] We have converted annual data into quarterly frequency using the linear interpolation technique by following the previous literature i.e. Tang and Chua (2012); Shahbaz et al. (2014); and Alam et al. (2015).

The considered variables of the study are measured as follows: Energy consumption (*enc*) is measured in kg of oil equivalent (kgoe) per capita, GDP per capita (*gdp*) is measured in constant 2005 US dollars. The stock market (*stk*) variables are the ratio of stock market capitalisation (*stkcap*) to GDP, which captures the size of local equity market, and stock market turnover ratio (*stkto*), a measure of efficiency that measures trading relative to the size of the market, respectively. Industry value added as % of GDP is used to measure industrialisation (*ind*). The trade openness (*tr*) is measured as the sum of exports and imports (both goods and services) as a share of GDP. Finally, with trade openness, we consider foreign direct investment (*fdi*) as an additional source of internationalisation, and are measured in net inflows as a share of GDP.[10] The required data on these variables were sourced from the World Development Indicator series (WDI) published by the World Bank.

3.2 Model specification and methodology

In a panel study, Narayan and Popp (2012) establish negative long-run relationship between energy consumption and economic growth for most African countries (except Uganda, Zambia, and Zimbabwe). Al-mulali and Sab (2012) emphasise the role of financial investment in enhancing energy projects in case of sub-Saharan African countries. Following these studies, we specify here our empirical model with the key determinants of energy demand in Africa. Further, Sadorsky (2012) and Aïssa et al. (2014) establish that international trade was beneficial for 11 African countries in their panel study in enhancing economic growth. In this respect, changing energy-mix will play a key role in technology transfer. Following these studies and others, we specify the empirical model of energy consumption in case of African frontier market economies as follows:

[10] Exports, imports, foreign direct investment are avenues in opening the domestic market to the world.

$$ENC_{it} = f(GDP_{it}, STK_{it}, IND_{it}, TR_{it}, FDI_{it}) \quad (1)$$

Where energy demand (ENC) is generated through economic activity (measured in per capita GDP), stock market activity (STK), industrialisation (IND) and internationalisation. The variables for internationalisation include trade openness (TR) and foreign direct investment (FDI). More specifically, as the per capita income rises, people tend to buy more energy consuming goods such as refrigerator, television, washing machine, etc., which increases demand for energy. Similarly, the growths of stock market development, industrialization, trade openness and FDI inflows have significant positive impact on the economies activities. Hence, these all factors play an important role for energy demand. In the above equation, the countries and time-period are represented by the subscript $i = 1,\ldots N$ and $t = 1,\ldots T$, respectively.

For empirical analysis, we consider the logarithmic version of the model. The Equation (2) is derived by taking the natural logarithms of Equation (1). Lower case letters denote the natural log of upper case letters and a random error term (ε) is also included in the following empirical model:[11]

$$enc_{it} = \beta_{1i} gdp_{it} + \beta_{2i} stk_{it} + \beta_{3i} ind_{it} + \beta_{4i} tr_{it} + \beta_{i5} fdi_{it} + \varepsilon_{it} \quad (2)$$

Where, $\beta_{1i} \ldots \beta_{5i}$ denote the elasticities of the independent variables with respect to the energy consumption.

[11] Lower case denoted variables are used for reporting purposes. Given that our variables are measured in different units so we consider the log-version of the model following Ulusoy and Demiralay (2017). A number of other researchers in the literature (e.g. Bhattacharya et al. 2016; Paramati, Alam, and Chen 2017b) argued that the transformation of data series into natural logarithms helps to avoid the problems associated with the distributional properties of the data series and also estimated coefficients in a regression model can be interpreted as elasticities. Given that we converted our data series into natural logarithms before the analyses has begun.

The empirical estimations involve four steps. In step 1, we analyse cross-sectional dependence and check stationarity of the series, step 2 conducts cointegration test to examine the long-run dynamics considering cross-sectional dependence across countries. In step 3 establishment of both the panel-wide and country-specific long-run elasticities of energy consumption are considered. The final step identifies the direction of causality by accounting for heterogeneity across cross-sections.[12]

4. Empirical findings and discussion

4.1 Preliminary analysis

Table 2 presents the compounded annual growth rates for each of the variables for the defined sample period from 1991 to 2012. The growth rate of energy consumption is positive for five countries. Morocco has the highest rate, with an average annual growth of 2.72%. The rate is negative for only two countries, Nigeria (-0.20%) and Zimbabwe (-1.27%) in the current panel. The stock market capitalisation has a positive growth rate for all selected countries with the highest rate for Morocco and the lowest rate for Nigeria. Out of seven countries, five (Kenya, Morocco, Nigeria, Tunisia and Zimbabwe) have positive growth rates of stock market turnover, while Botswana (-3.26%) and Ghana (-4.91%) have negative rates. The FDI is highest in Zimbabwe (24.60%) and lowest in Nigeria (-2.34%). This evidences that the African frontier market economies have varying growth rates across the variables.

Table 2 also reports summary statistics for the selected African frontier market economies from 1991 to 2012. On average, Botswana had the highest per capita energy consumption (1023.33 kg of oil equivalent), per capita GDP ($5009.21), industrialisation (46.29 % of GDP), trade

[12] We do not discuss these steps to conserve the space, see Alam et al. (2017).

openness (92.35 % of GDP) and FDI inflows (12.49 % of GDP) for this period. Morocco had the lowest per capita energy consumption at 396.44 kgoe while Ghana had the lowest per capita GDP at $487.90. Kenya had both the lowest industrialisation (17.91 % of GDP) and FDI inflow (0.60 % of GDP), and Nigeria had the lowest trade openness (60.42 % of GDP). Finally, the market capitalisation to GDP and turnover ratio was higher for Zimbabwe (87.19%) and Morocco (17.50%) and lower for Tunisia (13.45%) and Ghana (3.37%), respectively. The consolidated statistics on the panel data set also show the average per capita energy consumption, per capita GDP, stock market capitalisation, turnover ratio, industrialisation, trade openness, and FDI inflows.

[Insert Table 2 here]

Table 3 reports unconditional correlations among the variables of the study. The correlations confirm that stock market indicators are positively correlated with energy consumption. Similarly, per capita GDP, industrialization, trade openness and FDI also positively associated with the energy consumption. These results imply that the growth in stock market indicators, along with other considered variables, increases energy consumption in African frontier market economies. Therefore, we suggest that stock market development and energy consumption are positively associated in African frontier market economies. However, we confirm this association with rigorous analysis in the following.

[Insert Table 3 here]

4.2 Major findings and discussion

The selected African frontier market economies can be cross-sectionally dependent due to similar economic structure. According to O'Connell (1998) and others, first generation panel unit root

tests may not be reliable due to low power of the test and this tends to over-reject the null of a unit root.

To overcome this problem, the tests for CD and CIPS developed by Pesaran (2004, 2007) were applied on a given panel dataset. Mathematical expressions for the CD and CIPS test statistics can be found in Wu et al. (2010) and the results of these calculations for the current data set are presented in Table 4. The CD test strongly rejects the null hypothesis of no cross-sectional dependence for the current series at 1% significance level, indicating that the second generation panel unit tests are more appropriate for this data. The results of CIPS test suggest that all of the variables are integrated of same order i.e. I (1). More specifically, following Alam et al. (2017), the CIPS test results on level data suggest that the null hypothesis of a unit root cannot be rejected at 5% significance level for all of the variables. However, the null hypothesis can be strongly rejected at 1% significance level for all of the variables when it is applied on their first differences.

[Insert Table 4 here]

Once the existence of a panel unit root has been established, the next step is to examine the long-run association among the considered variables. For this purpose, we employ the robust panel cointegration test developed by Westerlund (2007) which accounts for cross-sectional dependence in the analysis.[13] The results are reported in Table 5, in which *stkcap* and *stkto* are the stock market capitalization and turnover ratio, respectively. The calculated group and panel statistics values indicate that the null hypothesis of no cointegration is strongly rejected using the bootstrapped p-

[13] This is a recent trend (e.g., see Alam et al., 2017 and Paramati et al., 2016) to apply the panel cointegration test which accounts for cross-sectional dependence in the analysis. On the other hand, the previous literature (e.g., Alam and Paramati, 2015) focused on the conventional cointegration techniques to analyse the long-run dynamics among the considered variables.

values, reflecting the presence of cross-sectional dependence. These findings therefore confirm the presence of long-run equilibrium relationship among the considered variables.

[Insert Tables 5 here]

Cointegration analysis does not provide the signs and magnitudes of the coefficients in Equation (2). For this purpose, the FMOLS technique by Pedroni (2000) was employed to estimate long-run elasticities. Table 6 and 7 report the findings from the FMOLS technique for the full panel and for the individual countries, respectively.[14]

For the full panel, a 1% increase in *stkcap* and *stkto* raises energy consumption by 0.030% and 0.034%, respectively. The long-run elasticities are similar for both the stock market indicators for energy consumption. Sadorsky (2010) reports long-run elasticities between 0.26 and 0.37% for twenty two emerging countries, including Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Thailand and Turkey. Therefore, an increase in stock market activity increases energy demand at a slower pace for the selected African frontier market economies than those of emerging countries reported by Sadorsky (2010). Similarly, the findings of Paramati et al. (2016) documented that a 1% increase in stock market development raises energy demand by 0.085% in a panel of 20 emerging market economies while another study by Paramati et al. (2017c) also showed that a 1% increase in stock market growth raises energy use in the EU and G20 countries by 0.078% and 0.048%, respectively.

[14] A number of recent empirical studies (e.g. Bhattacharya, et al. 2017; Paramati et al. 2017e) have applied panel FMOLS models to estimate the long-run elasticities.

A 1% growth in *gdp* raises *enc* by 0.40 to 0.41% across the full suite of the current models. The long-run elasticity values are significantly lower than the values between 1.13 and 1.67 reported by Sadorsky (2010). The current findings suggest that the selected countries have potential scope to expand stock market and economic activities, and which may have a significant impact on energy demand. The long-run effect of *ind* on *enc* varies between 0.15 and 0.18%; while the *tr* variable has 0.06 to 0.08% effect on *enc*. The *fdi* (-0.04%) variable has a negative effect on *enc* when *stkcap* is used as the stock market indicator. These findings suggest that both industrialisation (*ind)* and trade openness (*tr)* increases energy consumption *(enc)* in African frontier market economies. Furthermore, the current results indicate that the recent significant FDI inflows into these countries have worked in favour of energy saving. It can further be argued that energy saving technology is transferred from Western countries to these African economies through the FDI inflows.

[Insert Tables 6 here]

The FMOLS models were employed to understand the dynamic long-run energy consumption elasticities across the individual countries. In the long-run, country specific elasticities vary across the sample countries. For Botswana, *gdp* has a positive and significant effect on *enc*, and the calculated elasticity ranges from 0.23 to 0.48. Stock market (measured in *stkcap*) and *ind* have a positive and significant effect on *enc* with elasticity values of 0.05 and 0.17, respectively, while *tr* and *fdi* have a significant negative impact on *enc* with elasticity value of -0.28 and -0.06, respectively. For Ghana, only *tr* has a positive effect on *enc*, with elasticity from 0.10 to 0.11, while all other variables are statistically insignificant. For Kenya, *gdp* has a positive and significant effect on *enc*, and elasticity ranges from 0.65 to 0.67. Stock market (both indicators)

is not significant in influencing energy consumption, while the *ind*, *fdi* and *tr* variables have statistically significant values with negative elasticities.

In the case of Morocco, both stock market indicators are positive and significant with elasticity values between 0.02 and 0.04, while *gdp* is positive and significant with elasticity between 0.72 and 0.82. The *tr* variable is positive and significant, and elasticity ranges between 0.21 and 0.25. Both *ind* (-0.14) and *fdi* (-0.01) have a negative impact on *enc*. For Nigeria, only *ind* has a significant positive effect on *enc*, with elasticity from 0.04 to 0.05. In the case of Tunisia, *gdp* has a significant positive effect on *enc* with elasticity between 0.55 and 0.60. Stock market (*stkto*) also has positive impact on *enc* with an elasticity of 0.02, while *ind* has a significant negative effect with elasticity values between -0.38 and 0.52. For Zimbabwe, stock market (both indicators) and *tr* have significant negative elasticity ranges of 0.01 to 0.04 and 0.14 to 0.18, respectively, while *gdp*, *fdi* and *ind* variables are significant with positive values of elasticity.

In summary, the country specific elasticities show that economic activity has a significant long-run effect on energy consumption, and stock market activities also have positive influence on energy consumption for Botswana, Morocco and Tunisia. This result was also positive for Kenya and Nigeria, but not statistically significant. For Zimbabwe alone, the effect of stock market activity on energy consumption is negative, and the effect of foreign direct investment is positive and significant. In the case of Botswana, Kenya and Morocco, FDI has a negative effect. The effects of industrialisation and trade on energy consumption are also mixed across the panel.

These findings indicate that rising income levels (per capita GDP) increase the demand for energy in selective frontier markets in Africa. With increase in income, citizens will consume more white goods and therefore, increases overall energy consumption. Likewise, the stock market

development in these economies increases energy demand through the increasing economic activities in the country. The stock markets provide additional funds for entrepreneurs by listing their company equities, eventually leading to increased economic activity and higher energy demand. Both FDI inflows and trade openness can have a positive or negative effect on the energy consumption of these countries. It primarily depends on the nature of FDI inflows and the extent to which these individual economies are opened to international exports and imports. For instance, if these economies invite foreign capital into the manufacturing sectors, there is a possibility that the FDI inflows can bring them energy efficiency technologies from foreign countries. Therefore, FDI inflows may decrease energy demand in the host country. On the other hand, FDI inflows can increase the demand for energy if host country policy makers do not account for the influx of such energy efficient technologies.

Similarly, international trade can increase or decrease energy demand. For instance, if a country depends more on imports than exports, then there is a possibility that trade openness may decrease energy demand as the imported goods are manufactured in foreign countries. Conversely, trade openness may increase the demand for energy if a country largely depends on exports rather than on imports. Overall, our findings suggest that the stock market indicators have considerable positive impact on energy consumption in African frontier market. The investment opportunities through sustainable energy fund by the African Development Bank plays a vital role for these purposes.

[Insert Tables 7 here]

The direction of causality was determined using the pairwise Dumitrescu and Hurlin (2012) panel causality test.[15] This test assumes all the coefficients to be different across cross-sections. This test requires the variables to be stationary; therefore, it was applied on the first difference of the series and the results are reported in Table 8. The short-run pairwise causality test results show the evidence of bidirectional causality between *stkcap* and *enc*, *stkto* and *enc*, and *ind* and *enc*. This implies that both stock market activities and industrialisation induce increased energy consumption with a feedback effect in the case of the selected African countries. This is similar to the reported results of Al-Mulali and Sab (2012), and Aslan et al. (2014). In the case of Sub-Saharan Africa, Le (2016) also established bi-directional causality between financial development and energy consumption. On the other hand, the findings of Paramati et al. (2016) showed the unidirectional causality that runs from stock market growth to energy consumption in 20 emerging market economies. Further, the current results show that *enc* has a unidirectional effect on *fdi* and *tr* has a unidirectional effect on *enc*. Across the panel, conservative energy consumption will reduce foreign direct investment, while increase in trade has a dampening effect on energy consumption.

[Insert Table 8 here]

4.3. Robustness check

For the purpose of robustness check, we first employ a unit root test, under the null hypothesis of stationarity, to examine with the presence of two structural breaks. We use this test based on the approach suggested by Clemente, Montanes, and Reyes (1998). The country-specific unit root test results are displayed in Table 9. The findings show that the null hypothesis of a stationary can be rejected for at least some countries for all of the variables. This therefore implies the presence of

[15] Bhattacharya et al. (2016 and Paramati et al. 2017d) report the significance of heterogeneous panel non-causality test in identifying the causal relationship between the variables.

structural breaks in our data series. Given these findings, we further apply a panel cointegration test using the framework of Westerlund and Edgerton (2008). This is a robust technique as it accounts for cross-sectional dependence and structural breaks while estimating long-run equilibrium relationship among the variables. The results of this test are reported in Table 10. The findings show that the energy consumption has a significant long-run relationship with *gdp, stkcap, ind, tr*, and *fdi* with the presence of cross-sectional dependence and structural breaks, while only energy consumption and *stkto* have a cointegration relationship without a structural break. Given the findings of our study, we suggest that there is a significant long-run equilibrium relationship among the studied variables.

[Insert Table 9 here]

[Insert Table 10 here]

5. Conclusion and policy suggestions

In Africa, current policies in eliminating energy poverty are not adequate both in terms of scale and pace. Following current trend, more people will be without access to modern energy services by 2030 than today (IEA, UNDP and UNIDO, 2010). This is a real concern for the region. To assist the current debate, this is the first attempt in empirical energy economics literature in exploring the effect of continued stock market development and foreign investment on energy consumption across a panel of seven African frontier market economies. We consider four drivers of energy consumption viz. gross domestic product, stock market development, industrialisation and internationalisation. Cross-sectional dependence and heterogeneity were considered across the panel. Interdependencies and regional differences are established across our sample countries.

The findings from the Westerlund cointegration test established that the drivers of energy consumption in the current model are cointegrated. Our findings from the panel estimations indicate that all of the variables except foreign direct investment increase energy consumption in the long-run. However, the findings do vary between countries, and foreign direct investment, industrialisation and trade openness have negative effects for some countries.

The findings in general indicate that both stock market development and economic growth increase energy consumption. This is supported by Sadorsky (2010 and 2011), Ozturk and Acaravci (2013), and Khan et al. (2014) in the context of overall financial development. However, this trend could not be established across all countries in the panel when stock market indicators are considered. This is similar to Coban and Topcu (2013) for new EU members. They also could not establish any effect of stock market development on economic growth. We conclude that the findings were sensitive to the stages of financial development for individual countries and the indicators used for analysis.

We establish that industrialisation and internationalisation will lead to energy saving for most of the countries under the study. This has been emphasised recently by the Global and African investment institutions. They identify the growth potential and revenue prospects of African infrastructure and related foreign investment are some key ingredients. Increases in industrialisation and foreign direct investment induced new and improved technology, growth and sources of competitive advantages. This in turn reduces energy consumption in the long-run.

The energy resources in the region are sufficient to meet future demand; however, uneven distribution, regulatory barriers and inadequate infrastructure are noted to be the primary sources of known persistent energy poverty. Improving energy efficiency, providing appropriate

infrastructure and instigating a drive towards renewable-energy development through private and foreign investments are major initiatives to follow in underpinning sustainable growth in future. In doing so, these African frontier market economies need to balance foreign investment, trade and stock market activities with better energy integration for sustainable development. Our findings reflect that this balance is necessary for future economic development.

On a final note, to set actions for effective energy planning, greater level of investment is needed at the national and regional level in Africa. Our findings reflect deeper regional integration is necessary across frontier countries incorporating financial, trade and economic activities for a sustainable energy sector. Improved governance and regulatory measures will create such environment for investment purposes and will lead Africa's energy and economic future to a different path from the past. In this respect, the role of stock market will play a major role in attracting institutional investors to invest in frontier markets.

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Table 1: The summary of literature relating to financial development and energy consumption

Author	Country studied	Time period	Main objective	Estimations	Major Findings
Sadorsky (2010)	22 emerging economies	1990-2006	The effect of financial development on energy consumption	GMM technique	The financial development has a positive and significant impact on energy consumption
Sadorsky (2011)	9 Central and Eastern European countries	1996-2006	The role of financial development on energy consumption	System GMM	The financial development positively contributes for energy consumption in the considered sample countries
Çoban and Topcu (2013)	EU member countries	1990-2011	The nexus between financial development and energy consumption	System-GMM	Findings confirm that financial development leads to increase energy consumption in old EU member countries
Chang (2015)	53 countries	1999-2008	The nonlinear effects of financial development and income on energy consumption	Panel threshold regression	The results suggest that financial developed increases energy consumption in non-high income countries, while it declines in advanced economies
Furuoka (2015)	Asian countries	1980-2012	The relationship between financial development and energy consumption	Cointegration and causality tests	The long-run relationship among the variables is established and unidirectional causality that runs from energy consumption to financial development
Komal and Abbas (2015)	Pakistan	1972-2012	The effect of financial development on energy consumption via economic growth	System-GMM	Positive and significant impact of economic growth and urbanization on energy consumption are established; Financial development has a positive and significant effect on energy consumption via the economic growth
Ziaei (2015)	Europe, East Asia and Oceania	1989-2011	The effects of financial indicator shocks on energy consumption and CO_2 emissions	Panel Vector Auto Regression (PVAR) models	The strength of energy consumption shock on stock return in the European countries is stronger than East Asian and Oceania countries; Shocks to stock return influences energy consumption in the case of East Asia and Oceania countries
Paramati et al. (2016)	20 emerging countries	1991-2012	The effects of FDI inflows , stock market activities and economic output on clean energy consumption	Panel estimations	The empirical results on long-run elasticities display that economic output, FDI inflows and stock market developments have a significant positive impact on clean energy consumption
Kutan et al. (2017)	4 emerging economies	1990-2012	The role of FDI inflows and stock market development on renewable energy consumption	Panel estimation techniques	The results show that both FDI inflows and stock market development increase renewable energy consumption
Paramati et al. (2017c)	The EU, the G20 and OECD countries	1993-2012	The impact of both domestic (stock market) and foreign (FDI inflows) capital on clean energy uses	Panel estimation	The findings confirm that both the stock markets and FDI inflows significantly contribute for higher clean energy uses across the panels.
Ulusoy and Demiralay (2017)	OECD countries	1996-2011	The effect of stock market developments on oil and electricity demand	Partial adjustment model	Demand for energy is price inelastic; stock market size and liquidity affect energy consumption

Table 2: Compounded annual growth rates and summary statistics, 1991-2012

Country	*enc*	*gdp*	*stkcap*	*stkto*	*ind*	*tr*	*fdi*
Compounded annual growth rates							
Botswana	1.050	2.490	7.370	-3.260	-2.300	-0.240	0.940
Ghana	0.640	2.910	9.520	-4.910	2.400	4.060	16.110
Kenya	0.320	0.400	8.910	5.610	-0.560	1.170	4.710
Morocco	2.720	2.200	11.020	2.110	-0.320	2.290	4.430
Nigeria	-0.200	2.810	2.680	13.390	-2.410	-1.680	-2.340
Tunisia	1.970	2.850	5.970	4.790	-0.360	1.000	5.920
Zimbabwe	-1.270	-2.170	9.590	5.840	-0.760	3.980	24.600
Summary statistics							
Botswana	1023.330	5009.214	22.673	5.256	46.292	92.354	12.486
Ghana	398.522	487.896	13.770	3.365	24.990	79.403	3.596
Kenya	451.770	529.954	24.900	5.948	17.911	61.389	0.601
Morocco	396.443	1843.019	40.439	17.503	29.912	65.791	1.642
Nigeria	736.586	704.551	14.079	8.883	39.499	60.415	3.767
Tunisia	776.058	2902.751	13.451	12.719	30.958	91.448	2.946
Zimbabwe	782.311	559.127	87.190	11.563	29.486	83.402	1.435
Consolidated							
Mean	652.146	1719.502	30.929	9.320	31.293	76.315	3.782
Std. Dev.	232.164	1647.635	48.361	8.373	9.717	18.934	4.406
Minimum	291.063	344.742	1.151	0.554	16.018	42.309	0.007
Maximum	1149.242	6683.660	487.824	46.965	58.936	149.586	23.455

Notes: Compounded annual growth rates were calculated using original data; *Variables are: enc*: energy use (kg of oil equivalent per capita); *gdp*: gdp per capita (constant 2005 US$); *stkcap*: market capitalization of listed companies (% of GDP);*stkto*: stocks traded, turnover ratio (%); *ind*: Industry, value added (% of GDP); *tr*: trade (% of GDP) ; *fdi:* foreign direct investment, net inflows (% of GDP).

Table 3: Unconditional correlations among the variables

	enc	*gdp*	*stkcap*	*stkto*	*Ind*	*tr*	*fdi*
enc	1.000	0.507	0.077	0.047	0.628	0.441	0.493
gdp		1.000	-0.026	0.220	0.535	0.407	0.457
stkcap			1.000	0.380	-0.078	0.234	-0.152
stkto				1.000	-0.016	0.103	-0.153
ind					1.000	0.347	0.549
tr						1.000	0.485
fdi							1.000

Note: Correlations were estimated using log data.

Table 4: Tests for cross-sectional dependence and unit root

Variable	*enc*	*gdp*	*Stkcap*	*stkto*	*ind*	*tr*	*fdi*
Pesaran CD test	4.050***	16.560***	23.080***	2.300**	3.400***	4.830***	3.900***
P-value	0.000	0.000	0.000	0.021	0.001	0.000	0.000
The unit root test with cross-sectional dependence							
CIPS test (level)	-1.352	-0.817	-0.204	1.568	1.870	-1.582	-1.221
CIPS test (first difference)	-6.280***	-4.848***	-5.384***	-6.091***	-5.746***	-5.944***	-8.326***

Notes: '**' & '***' indicate the rejection of the null hypothesis of cross-sectional independence (CD test) and the null hypothesis of a unit root at the 5% and 1% significance levels, respectively. The CIPS test is estimated using constant and lag length is selected based on SIC.

Table 5: Westerlund (2007) panel cointegration test

Test	Value	*p*-value[a]	*p*-value[b]
enc = f (gdp, stkcap, ind, tr, fdi)			
Group-τ	-2.962	0.190	0.043**
Group-α	-15.626	0.417	0.003***
Panel-τ	-7.406	0.148	0.055*
Panel-α	-12.806	0.318	0.010**
enc = f (gdp, stkto, ind, tr, fdi)			
Group-τ	-2.980	0.177	0.035**
Group-α	-14.030	0.619	0.013**
Panel-τ	-7.812	0.078*	0.040**
Panel-α	-12.720	0.328	0.013**

Notes: The null hypothesis assumes no cointegration;
The test is estimated using constant with two lags;
[a] The *p*-values (asymptotic) are for a one-sided test based on the normal distribution;
[b] The *p*-values (bootstrapped) are for a one-sided test based on 400 bootstrap replications;
'*' '**' & '***' indicate the rejection of null hypothesis at 10%, 5% and 1% significance levels, respectively.

Table 6: The FMOLS results for the panel: Long-run energy consumption elasticities

Variable	Coefficient	Probability	Coefficient	Probability
gdp	0.398***	0.000	0.410***	0.000
stkcap	0.030***	0.000		
stkto			0.034***	0.000
ind	0.177***	0.000	0.151***	0.000
tr	0.057***	0.000	0.079***	0.000
fdi	-0.044***	0.001	-0.021	0.121

Note: '***' indicate the significance level at 1%.

Table 7: The FMOLS findings: Country specific long-run energy elasticities

Country		*gdp*	*stkcap*	*stkto*	*Ind*	*tr*	*fdi*	constant	R-squared
Botswana	Coefficient	0.228**	0.047*		0.075	-0.077	-0.061**	5.065***	0.759
	Prob.	0.015	0.056		0.289	0.424	0.014	0.000	
	Coefficient	0.484***		0.027	0.166**	-0.279**	-0.031	3.476***	0.728
	Prob.	0.000		0.226	0.043	0.019	0.139	0.000	
Ghana	Coefficient	0.016	-0.006		0.026	0.118***	0.014	5.298***	0.706
	Prob.	0.780	0.383		0.604	0.001	0.132	0.000	
	Coefficient	0.035		-0.017	0.012	0.102***	0.010	5.301***	0.727
	Prob.	0.525		0.115	0.801	0.003	0.213	0.000	
Kenya	Coefficient	0.674***	0.004		-0.121**	-0.049**	-0.005**	2.421***	0.885
	Prob.	0.000	0.394		0.029	0.049	0.042	0.000	
	Coefficient	0.645***		0.005	-0.124**	-0.030	-0.005*	2.539***	0.890
	Prob.	0.000		0.265	0.031	0.119	0.057	0.000	
Morocco	Coefficient	0.723***	0.038***		-0.029	0.207***	-0.001	-0.352	0.990
	Prob.	0.000	0.001		0.655	0.003	0.813	0.360	
	Coefficient	0.822***		0.017***	-0.143**	0.250***	-0.009***	-0.812**	0.990
	Prob.	0.000		0.001	0.010	0.000	0.000	0.025	
Nigeria	Coefficient	-0.011	0.000		0.043**	0.008	-0.012	6.496***	0.250
	Prob.	0.662	0.978		0.046	0.762	0.208	0.000	
	Coefficient	-0.026		0.002	0.049**	-0.008	-0.013	6.638***	0.263
	Prob.	0.284		0.672	0.026	0.785	0.138	0.000	
Tunisia	Coefficient	0.599***	0.000		-0.376**	0.024	0.005	3.056***	0.982
	Prob.	0.000	0.978		0.032	0.830	0.556	0.000	
	Coefficient	0.548***		0.019**	-0.518***	0.090	0.001	3.614***	0.985
	Prob.	0.000		0.014	0.001	0.389	0.860	0.000	
Zimbabwe	Coefficient	0.248***	-0.011***		0.266***	-0.184***	0.017***	5.059***	0.965
	Prob.	0.000	0.006		0.000	0.000	0.000	0.000	
	Coefficient	0.286***		-0.037***	0.190***	-0.136***	0.015***	4.900***	0.975
	Prob.	0.000		0.000	0.000	0.000	0.000	0.000	

Notes: '*' '**' & '***' indicate the significance levels at 10%, 5% and 1%, respectively. For each country, we consider *stkcap* and *stkto* as the stock market indicators for each set of regression.

Table 8: Pairwise heterogeneous panel causality test

Null Hypothesis:	Zbar-Stat.	Probability	Lags
gdp does not homogeneously cause *enc*	-2.169**	0.030	3
enc does not homogeneously cause *gdp*	-1.306	0.192	
stkcap does not homogeneously cause *enc*	2.121**	0.034	4
enc does not homogeneously cause *stkcap*	-2.113**	0.035	
stkto does not homogeneously cause *enc*	-2.527**	0.012	3
enc does not homogeneously cause *stkto*	-1.993**	0.046	
ind does not homogeneously cause *enc*	-2.073**	0.038	3
enc does not homogeneously cause *ind*	-1.836*	0.066	
tr does not homogeneously cause *enc*	-2.142**	0.032	3
enc does not homogeneously cause *tr*	-1.580	0.114	
fdi does not homogeneously cause *enc*	0.505	0.614	5
enc does not homogeneously cause *fdi*	3.990***	0.000	

Note: '*' '**' & '***' indicate the rejection of null hypothesis at 10%, 5% and 1% significance levels, respectively.

Table 9: Country-specific KPSS stationarity tests with two Structural Breaks (Additive Outlier-AO)

Country	t-statistics	TB1	TB2	t-statistics	TB1	TB2	t-statistics	TB1	TB2
	enc			gdp			stkcap		
Botswana	6.227* *	1999	2009	16.165* *	1998	2006	7.953* *	1998	2003
Ghana	-1.523	1999	2005	12.476* *	2000	2009	-4.762	1994	1998
Kenya	7.349* *	2007	2010	13.980* *	1993	2008	10.820* *	1997	2004
Morocco	13.970* *	2000	2006	11.965* *	2002	2007	11.773* *	1996	2005
Nigeria	-4.664	2002	2010	5.273	2005	2008	-5.264	2005	2011
Tunisia	9.336* *	1999	2005	13.555* *	1999	2005	3.402	1995	2011
Zimbabwe	-6.782* *	2001	2009	-2.727	2004	2009	1.766	2001	2006
	stkto			ind			tr		
Botswana	-5.638* *	2000	2005	-5.918* *	1995	2010	-4.901	1998	2001
Ghana	2.563	1996	1998	-8.275* *	1994	2007	-4.339	1998	2007
Kenya	13.610* *	1995	2004	4.763	1996	2006	10.543* *	1997	2005
Morocco	4.910	1997	2006	4.551	2009	2004	13.565* *	2001	2006
Nigeria	8.207* *	1997	2002	-5.594* *	2003	2011	-4.775	1998	2005
Tunisia	3.294	1995	2006	4.315	1998	2009	0.140	2009	2009
Zimbabwe	-3.222	1998	2004	7.545* *	1997	2007	11.603* *	1996	2009
	fdi								
Botswana	6.101* *	1993	2002						
Ghana	12.413* *	1993	2007						
Kenya	4.846	2001	2007						
Morocco	13.732* *	1996	2000						
Nigeria	-4.523	1996	2001						
Tunisia	-4.276	2007	2010						
Zimbabwe	6.460* *	2001	2006						

Notes: ** denotes significance at the 5% level, critical value is 5.490. TB1 and TB2 are two structural breaks.

Table 10: Panel cointegration tests with cross-sectional dependence and structural breaks: Westerlund and Edgerton (2008)

	$Z_\tau(N)$		$Z_\emptyset(N)$		$Z_\tau(N)$		$Z_\emptyset(N)$		$Z_\tau(N)$		$Z_\emptyset(N)$	
Model	Value	p-value	value	p-value	Value	p-value	value	p-value	value	p-value	value	p-value
	Gdp				*Stkcap*				*stkto*			
No break	-5.414***	0.000	-9.726***	0.000	-5.392***	0.000	-11.018***	0.000	-2.037**	0.021	-2.651***	0.004
Level Break	0.214	0.585	-1.432*	0.076	4.740	1.000	3.185	0.999	2.722	0.997	1.708	0.956
Regime Shift	1.766	0.961	1.306	0.904	-5.548***	0.000	-1.799**	0.036	6.812	1.000	2.987	0.999
	Ind				*Tr*				*fdi*			
No break	2.087	0.982	0.682	0.752	-6.104***	0.000	-12.162***	0.000	-4.934***	0.000	-9.715***	0.000
Level Break	-4.387***	0.000	-5.295***	0.000	0.893	0.814	0.559	0.712	-0.898	0.185	-2.346***	0.009
Regime Shift	-2.166**	0.015	-2.444***	0.007	-5.231***	0.000	-8.392***	0.000	-3.968***	0.000	-5.222***	0.000

Notes: The test is conducted using Campbell and Perron (1991) automatic procedure to select the lag length. We consider three breaks determined by grid search at the minimum of the sum of squared residuals. The p-values are for a one-sided test based on the normal distribution. *, ** & *** indicate the rejection of the null hypothesis at the 10%, 5% and 1% levels, respectively.

Figure 1: Our sample of African frontier market economies within the African map